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Full Length Research Paper

Comparative growth and grain yield responses of soybean genotypes to phosphorous fertilizer application

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A two-year field study was conducted in 2003 and 2004 at the Teaching and Research Farm, Bolorunduro (8° 29' N, 4° 35'E) of the University of Ilorin, Nigeria, to evaluate the growth and grain yield responses of soybean genotypes to P fertilizer application. The trial was designed as 12 x 2 factorial experiments in randomized complete block and laid out in split-plots arrangements with four replications. The main plots were twelve soybean genotypes, while two P fertilizer levels constituted the sub-plots. Plant height, leaf area and number of branches per plant, crop growth rate, relative growth rate, net assimilation rate and leaf area ratio were measured at full flowering, while number of pods per plant and grain yield were obtained at harvest. Plant height, leaf area, number of branches, crop growth rate, relative growth rate varied significantly ($p < 0.001$) among genotypes and increased significantly ($p < 0.01$) with P fertilizer application in both years of study. Similarly, number of pods per plant and grain yield differed significantly among genotypes and increased with P application in the two years of study, but the differences were significant only in 2003. The results also showed appreciable variations in grain yields of the genotypes at 0 kg P ha^{-1}, suggesting variations in P use efficiency of the genotypes at low level of P. In conclusion, results of this study showed significant positive responses to P application.

Key words: Growth, grain yield, phosphorus fertilizer, *Glycine max*.

INTRODUCTION

Soybean (*Glycine max* (L) Merrill) is an important source of quality, inexpensive protein and oil. With an average protein content of 40% and oil content of 20%, soybean has the highest protein of all field crops, and is second only to groundnut (*Arachis hypogea*, L) in terms of oil content among food legumes. Recently, soybean and its by-products are being increasingly sought by people who are aware of the healthy benefits of soy-based protein and oil especially in developed countries. According to Leppik (1971), *G. max* is a promising pulse crop proposed for the alleviation of the acute shortage of protein and oil worldwide.

In spite of the great potentials of the crop, its production is still inadequate owing to low yields, resulting in a wide gap between what is currently produced and what is needed. As a way of improving production level, one of the major areas to consider is the development of high yielding and diseases and pests' resistant varieties and development of improved cultural management practices (Mahamood, 2008). The significant increase in the grain yield of soybean in U.S.A. has been partly attributed to the development and improvement of cultural practices (Modali, 2004). The use of fertilizer is considered to be one of the most important factors to increase crop yield. Phosphorous has been shown to be an essential element and its application has been shown to be important for growth, development and yield of soybean (Kakar et al., 2002). Fageria et al. (1995) had earlier reported that large quantity of P fertilizer may be required for successful soybean production.

The reports of the effects of P fertilizer on soybean are somewhat contradictory in Nigeria, where some workers have reported that yield components and grain yield in

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Table 1. General characteristics of the soil of the experimental site.

Soil property	2003	2004
pH (H_2O)	5.7	7.3
Organic matter (%)	0.41	0.36
Available P (Bray-1) (mg/kg soil)	3.8	4.1
Calcium (Cmol/kg soil)	3.6	1.1
Magnesium (cmol/kg soil)	1.2	1.6
Available potassium (cmol/kg soil)	0.06	0.18
Sodium (cmol/kg soil)	0.014	0.01
Total N (g/kg soil)	4.22	1.3
C. E. C. (cmol/kg)	5.09	2.83
Exchangeable acidity	0.24	0.04
Sand (g/kg soil)	862.4	840
Silt (g/kg soil)	86.4	80
Clay (g/kg)	51.2	80
Textural class	Loamy sand	Loamy sand

soybean were not significantly influenced by P application (Erhabor et al., 1999; Agboola and Obigbesan, 1997; Chiezey, 1999). However, Chiezey (2001) has reported that soil factors such as low level of P aggravate pods abortion thereby reducing yield in soybean. It has also been observed elsewhere that the soybean crop response to P is dependent on soil available P (Mallarino and Reuben, 2005), while Ferguson et al. (2006) have also reported that P application is not likely to increase seed yield at soil P concentration above 12 ppm.

Phosphorus deficiency has been shown to be an important fertility problem limiting legume production in the tropics (Fox and Kang, 1977). Under low P status, P fertilizer application to legume and its management are important in attaining high yields in soybean. P is not only essential for plant growth, its availability has been noted to affect the functioning of the biological nitrogen fixation system (Mclaughlin et al., 1990; Chien et al., 1993). Nevertheless, most farmers in Africa do not apply any form of fertilizer possibly due to unavailability of P fertilizer and or its high cost as well as inadequate information on the need to apply the fertilizer. It is therefore the objective of this study to evaluate the growth and yield of some genotypes of soybean with and without P fertilizer application.

MATERIALS AND METHODS

The experiments in this study were conducted at the Teaching and Research farm of the University of Ilorin, Bolorunduro (Latitude 8^o 29'N, Longitude 4^o 35'E, 310 m above sea level), during the 2003 and 2004 cropping seasons. The study area falls within the southern Guinea savannah zone of Nigeria with an average annual rainfall in the range of 1000 – 1240 mm. The soils are *Plinthustalf* (USDA, 1975) having sandy texture in the first 50 cm of the surface. The experiments were designed as factorial in randomized complete blocks in split-plots arrangement, with the genotypes (TGX 536-02D, TGX 1019-2EN, TGX 1485-1D, TGX 923-2E, TGX 1440-1E, Samsoy 2, TGX 1830-20E, TGX 1740-2F, TGX 1871-12E, TGX 1448-2E, TGX 1844-18E, TGX 1869-31E obtained from the International Institute of Tropical Agriculture (IITA), Nigeria) in the main plots and P levels (0 and 30 kg P ha^{-1}) in subplots. Factorial combinations of the genotype and P levels were replicated four times.

In each year of the study, the land was mechanically ploughed, harrowed and ridged before plots were marked out. Each plot was made up of five ridges 1 m apart and 5 m long. Planting was done each year on August 16th at an intra row spacing of 10 cm. Prior to planting, soil sample of the experimental plots was taken and analysed for physical and chemical characteristics (Table 1) using methods described by Tel and Hagarty (1984). Fertilizer application was made at 2 weeks after planting (WAP) using single super phosphate (18% P_2O_5). Weed control was achieved by the application of a pre-emergence herbicide, stomp (Pendimenthalin) at a rate equivalent to 5 l ha^{-1} using a knapsack sprayer immediately after planting. This was supplemented with one hand weeding using traditional hoe at 5 WAP. Data collected included plant height and number of branches per plant, leaf area at full flowering, while crop growth rate, relative growth rate, net assimilation rate, leaf area ratio determined using the classical equations described by Hunt (1978). At harvest, numbers of pods per plant and grain yield per plot were taken. Analyses of variance were performed on all data collected using Genstat 5.32 statistical package and means were separated by the Duncan's Multiple Range Test (DMRT) at 5% probability level.

RESULTS

Plant growth parameters responses

The results of the analyses of variance for the plant growth parameters are presented on Tables 2 and 4 for the 2003 and 2004 seasons respectively. The results show that all parameters significantly ($p < 0.001$) varied among the genotypes in 2003 (Table 2), while leaf area ratio, crop growth rate, relative growth rate and net assimilation rate are not significantly ($p > 0.05$) affected by genotype in 2004 (Table 4). Similarly, the effects of P

Table 2. Mean squares from the analyses of variance for plant growth parameters in 2003.

Source of variation	df	Mean squares						
		Leaf area (cm^2)	Leaf area ratio (cm^2 g^{-1})	Crop growth rate (g d^{-1})	Relative growth rate (g g^{-1} d^{-1})	Net assimilation rate (g m^{-2} d^{-1})	No. of branches	Plant height (cm)
Replicate	3	2.189E + 07	181.2	0.3115	0.0034	38.12	0.955	110.68
Genotype (G)	11	3.542E + 07***	1264.8***	0.5703***	0.0062***	105.44***	5.033***	675.07***
Error (a)	33	8.536E + 06	273.0	0.1086	0.012	21.39	0.08564	72.23
Phosphorous (P)	1	1.730E + 08***	1484.5***	3.5228***	0.024**	128.34ns	6.510***	787.76***
G x P	11	1.813E + 07ns	7910*	0.1582ns	0.0022ns	43.96ns	0.2150ns	24.69ns
Error (b)	36	1.211E + 07	323.6	0.2076	0.0023	38.16	0.2951	61.89

*, **, *** Significant at 5, 1, 0.1% probability level respectively; ns denotes not significant.

Table 3. Effects of genotype and P fertilizer application on growth of soybean in 2003.

Treatment	LA (cm^2)	LAR (cm^2 g^{-1})	CGR (g d^{-1})	RGR (g g^{-1} d^{-1})	NAR (g m^{-2} d^{-1})	No of branches	Plant height (cm)
Genotype							
TGX 536-02D	8663ab	113.5a	1.02abc	0.12abc	11.12cde	4.1cdef	59.38abc
TGX 1019-2EN	4180de	73.5d	0.77bcd	0.11abc	14.50ab	4.5cd	65.00a
TGX 1485-1D	5116cde	88.3bcd	1.16a	0.14a	16.37ab	4.0cde	43.13ef
TGX 923-2E	6750bcd	104.2ab	0.69cde	0.08def	7.37de	5.6a	66.25a
TGX 1440-1E	10711a	104.1ab	1.08ab	0.12abc	11.50cde	5.6a	60.00ab
SAMSOY 2	9034ab	83.2cd	1.29a	0.13ab	15.25abc	4.6bcd	51.25cde
TGX 1830-20E	6271bcde	77.4cd	1.03ab	0.14a	17.87a	3.4f	39.38f
TGX 1740-2F	4679de	73.3d	0.72cde	0.09cde	11.75bcd	3.8def	55.00bcd
TGX 1871-12E	4823de	90.0bcd	0.51de	0.05f	6.87e	4.9abc	50.63de
TGX 1448-2E	5669cde	88.3bcd	0.77bcd	0.09cde	9.87de	4.4cde	53.13bcd
TGX 1844-18E	7906abc	85.5cd	0.81bcd	0.10bcde	11.25cde	5.5ab	54.38bcd
TGX 1869-31E	3658e	92.6bc	0.39e	0.07ef	7.77de	3.5ef	38.13f
S.E.D	1460.8	8.26	0.1648	0.0174	2.312	0.463	4.249
CV (%)	32.0	13.1	27.4	24.5	27.8	14.6	11.3
Phosphorous level (Kg P ha^{-1})							
0	5112b	85.5	0.66b	0.09b	10.60b	4.2b	50.10b
30	7797a	93.4a	1.04a	0.12a	12.92a	4.8a	55.8a
S.E.D	710.2	3.67	0.093	0.01	1.261	0.111	1.606
CV (%)	53.9	20.1	53.5	48.0	52.5	12.1	14.9

Figures followed by the same letter(s) in each column are not significantly different by DMRT at 5% probability level.

fertilizer are significant ($p < 0.001$) for most parameters in both years of study, except net assimilation rate in 2003, and leaf area ratio and net assimilation rate in 2004. The genotypes x P effects are generally not significant for all parameters in both years, with the exception of leaf area ratio in 2003 and leaf area in 2004.

Across P levels, plant height was highest with TGX 923-2E in 2003, and the value was significantly better than in most other genotypes except TGX 536-02D, TGX1019-2EN and TGX 1440-1E (Table 3). TGX 1869-31E showed the lowest height which was however, not significantly poorer than in TGX 1485-1D and TGX 1830-20E. In 2004, plant height was highest with TGX 1448-2E, even though the value was not significantly better than in TGX 1019-2E, TGX 923-2E and TGX 1440.1E, while TGX 1830-20E has the lowest value which is similar to those of TGX 1845-1D and TGX 1869-31E (Table 5). In both years, application of 30 kg P ha^{-1} resulted in significantly taller plants than at 0 kg P ha^{-1}). Number of branches produced was similarly highest with TGX 923-2E and TGX1440-1E in 2003, and the value was significantly higher than in the other genotypes except TGX 1871-12E and TGX 1844-18E. Branching was lowest with TGX 1830-20E but the value was not

Table 4. Mean squares from the analyses of variance for plant growth parameters in 2004.

Source of variation	df	Mean squares						
		Leaf area (cm^2)	Leaf area ratio (cm^2 g^{-1})	Crop growth rate ($g\ d^{-1}$)	Relative growth rate ($g\ g^{-1}\ d^{-1}$)	Net assimilation rate ($g\ m^{-2}\ d^{-1}$)	No. of branches	Plant height (cm)
Replicate	3	3.785E+06	1054.0	0.0423	0.0004	30.43	0.6215	38.19
Genotype (G)	11	1.384E+07***	816.6ns	0.0801ns	0.0023ns	43.91ns	4.26004***	414.39***
Error (a)	33	3.583E+06	441.0	0.046	0.0029	64.44	0.6594	32.13
Phosphorous (P)	1	1.229E+08***	141.6***	0.2827***	0.0111**	36.26ns	6.5104***	937.50***
G x P	11	1.044E+07*	622.0ns	0.0376ns	0.0019ns	25.81ns	0.1695ns	19.32ns
Error (b)	36	4.636E+06	669.9	0.03303	0.0017	37.87	0.3646	19.44

*, **, *** Significant at 5, 1, 0.1% probability level respectively; ns denotes not significant.

Table 5. Effects of genotype and P fertilizer application on growth of soybean in 2004.

Treatment	LA (cm^2)	LAR (cm^2 g^{-1})	CGR ($g\ d^{-1}$)	RGR ($g\ g^{-1}\ d^{-1}$)	NAR ($g\ m^{-2}\ d^{-1}$)	No of branches	Plant height (cm)
Genotype							
TGX 536-02D	6331bc	76.6cd	0.36c	0.09ab	17.25a	4.3bcd	55.00bc
TGX 1019-2EN	6074c	75.1d	0.33c	0.08b	10.13a	4.4bc	58.75ab
TGX 1485-1D	7560bc	82.5bcd	0.45abc	0.11ab	14.25a	4.0bcde	44.38ef
TGX 923-2E	6758bc	101.9ab	0.35bc	0.09ab	9.63a	5.4a	60.00ab
TGX 1440-1E	6095c	91.80abcd	0.41bc	0.09ab	10.50a	5.1ab	58.75ab
SAMSOY 2	7244bc	78.1cd	0.41bc	0.10ab	14.00a	4.3bcd	48.13de
TGX 1830-20E	6145c	103a	0.35bc	0.09ab	9.88a	3.4e	41.25f
TGX 1740-2F	7199bc	96.9abc	0.36be	0.10ab	10.38a	4.1cde	56.25bc
TGX 1871-12E	7619bc	87.6abcd	0.46abc	0.11ab	12.0a	5.4a	50.63cd
TGX 1448-2E	10850a	100.8ab	0.67a	0.14a	14.25a	4.9abc	62.50a
TGX 1844-18E	8148b	94.0abcd	0.47abc	0.11ab	11.63a	5.5a	56.25bc
TGX 1869-31E	7361bc	91.2abcd	0.56ab	0.12ab	12.75a	3.5de	43.13ef
S.E.D	946.5	10.50	0.1082	0.0268	4.014	0.406	2.834
CV (%)	18.4	16.5	35.5	37.2	46.5	12.7	7.6
Phosphorous level (kg P ha^{-1})							
0	6151b	88.8a	0.38b	0.09b	11.60a	4.3b	49.79b
30	8413a	91.3a	0.49a	0.11a	12.83a	4.8a	56.04a
S.E.D	437.3	5.28	0.037	0.0083	1.256	0.123	0.900
CV (%)	29.6	28.7	42.1	40.1	50.4	13.4	8.3

Figures followed by the same letter(s) in each column by DMRT at 5% probability level.

significantly lower than in TGX 530-02D, TGX 1740-2F and TGX 1869-31E. However, in 2004, number of branches was highest with TGX 1844-18E, although the value was not significantly better than in TGX 923-2E, TGX 1440-1E and TGX1871-12E. Application of 30 kg P ha^{-1} produced significantly higher number of branches than at 0 kg P ha^{-1} in the two years of study.

Leaf area was highest with TGX 1440-1E, but the value was not significantly better than in TGX 536-02D, Samsoy 2 and TGX 1844-18E, while the lowest leaf area value was obtained with TGX 1869-31E in 2003. However, in 2004, TGX 1448-2E shows the largest leaf area which was significantly better than in other genotypes. TGX 1019-2EN has the lowest value which was however, not significantly worse than in most of the genotypes. Application of P resulted in significantly larger leaf areas in both years of study. Crop growth rate, relative growth rate and net assimilation rate values were highest with Samsoy 2, TGX1845-1D and TGX 1830-20E respectively in 2003. These growth indices were lowest with TGX 1869-31E for crop growth rate and TGX 1871-12E for both relative growth rate and net assimilation rate. While in 2004, most indices are highest with TGX 1448-2E and lowest with TGX 1830-20E, although the

Table 6. Mean squares from the analyses of variance for number of pods and grain yield.

Source of variation	df	Mean squares			
		2003		2004	
		No of pods	Grain yield	No of pods	Grain yield
Replication	3	419.3	66706	1596.9	438437
Genotype (G)	11	5192.7***	1321356***	1799.9**	757150***
Error (a)	33	862.9	227699	565.2	166089
Phosphorous (P)	1	17334.4***	2605357*	184.3ns	100104ns
G x P	11	1234.5ns	392910ns	940.0ns	177604**
Error (b)	36	787.1	378392	542.3	54757

*, **, *** Significant at 5, 1, 0.1% probability level respectively; ns denotes not significant.

differences are not significant. In both years of the study application P resulted in higher indices values with significant differences, except net assimilation rate in 2003 and leaf area ratio in 2004.

Grain yield responses

Number of pods per plant and grain yield varied significantly ($p < 0.001$) among the genotypes in the two years of the study (Table 6). However, the effects of P application were significant ($p < 0.001$) for both number of pods and grain yield only in 2003, while a significant genotype x P effect was obtained in 2004. Number of pods was highest with TGX 923-2E in 2003, but the value is not significantly better than in TGX 1440-1E, TGX 1448-2E, TGX 1844-18E and TGX 1869-31E (Table 7). Other genotypes show similar number of pods, even though the lowest value was obtained with TGX 1485-1D. Results on Table 7 show that number of pods was highest with TGX 1448-2E and lowest with TGX 1019-2EN in 2004. Across all genotypes, application of 30 kg P ha^{-1} resulted in significantly more number of pods than in no application in 2003, but has no significant effect in 2004 (Table 7).

Grain yield was highest with TGX 1448-2E across the P levels in both years of study and lowest with TGX 1871-12E in 2003 and Samsoy 2 in 2004 (Table 7). Across the genotypes, application of 30 kg P ha^{-1} increased grain yield in both years of study, although, the difference was significant only in 2003. In 2003, most genotypes responded positively to the application of 30 kg P ha^{-1} with significant differences with TGX 923-2E, Samsoy 2 and TGX 1448-2E, while TGX 1844-18E and TGX 1869-31E show non-significant negative responses. However, in 2004, TGX 1019-2EN, Samsoy 2 and TGX 1448-2E showed significantly positive responses to P application, TGX 1845-1D and TGX 1740-2F showed negative responses, while other genotypes were not appreciably affected by the application of P fertilizer (Table 7).

DISCUSSION

The use of fertilizer is considered to be one of the most important factors to increase crop yield. The results of the present study show that the application of 30 kg P ha^{-1} resulted in significant increase in plant height and number of branches per plant in both years of study. Earlier workers have shown that P is an essential element and its application is important for growth, development and yield of soybean (Kakar et al., 2002). Fageria et al. (1995) reported that large quantity of P fertilizer may be required for successful soybean production. The results of this study were also in consonance with the report of Fox and Kang (1977) that P deficiency is one important fertility problem limiting legume production and its management is important in attaining high yields in soybean. Other workers have reported that P is not only essential for plant growth, its availability has been noted to affect the functioning of the biological nitrogen fixation system (Mclaughlin et al., 1990; Chien et al., 1993). Nevertheless, the results of this study were in contrast with the findings of other workers who reported that yield components and grain yield in soybean were not significantly influenced by P application (Erhabor et al., 1999; Agboola and Obigbesan, 1997; Chiezey, 1999; Olofintoye, 2007).

The positive response of soybean to P application in this study was obviously due to the low available P of the experimental site (Table 1). It has been observed that the soybean crop response to P is dependent on soil available P (Mallarino and Rueben, 2005). Ferguson et al. (2006) have also reported that P application is not likely to increase grain yield at soil P concentration above 12 pmm (Bray-1 test). However, the results were in contrast with the report of Chiezey (1999) who observed no response to P application in spite of the low level of the element in the soil. The reported lack of responses to P application may be due to P occlusion, as binding of P has been reported to be a reason for non-response of crops to P application despite the initial low levels of P in the soil (Sample et al., 1980).

Table 7. Effects of P fertilizer application on number of pods per plant and grain yield in soybean genotypes.

Genotype	P level (Kg P ha^{-1})	2003 Pods (no plant^{-1})	2003 Grain yield (Kg ha^{-1})	2004 Pods (no plant^{-1})	2004 Grain yield (Kg ha^{-1})
TGX 536-02D	0	88.2a-g	976d-g	70.7d-h	1350c-f
	30	83a-g	1113c-g	86.2c-g	1325c-f
TGX 1019-2EN	0	58.5gh	1223c-g	88.2c-g	775gh
	30	59.7fgh	1383c-f	65.7e-h	1300def
TGX 1485-1D	0	83.2a-g	639fg	38h	1750a-d
	30	60.2e-h	1061c-f	75d-g	1250ef
TGX 923-2E	0	69.2 d-h	1521b-e	96cde	1075fgh
	30	73.2d-h	2264ab	155.8a	1275e-h
TGX 1440-1E	0	115.5a	1349c-f	99cde	1225efg
	30	84.0a-g	1633bcd	141.5ab	1200efg
Samsoy 2	0	40.2h	981def	67.7efg	725h
	30	76.0c-g	1719bcd	95.0cde	1100fgh
TGX 1830-20E	0	98.5a-d	851efg	52gh	1825ab
	30	72.5d-h	1186c-g	94c-f	1775abc
TGX 1740-2F	0	92.7a-f	1065c-g	56fgh	1850ab
	30	74.5d-g	1106c-g	75.5d-h	1475b-f
TGX 1871-12E	0	79.5b-g	536g	44h	1525b-f
	30	67.0d-h	975d-g	72d-h	1575b-e
TGX 1448-2E	0	93.2a-e	1415cde	85.7c-g	1750a-d
	30	111.2ab	2650a	149.8a	2125a
TGX 1844-18E	0	81.0b-g	1803bc	103.7b-e	1350c-f
	30	108.0abc	1695bcd	99.7cde	1525b-f
TGX 1869-31E	0	89.7a-g	1476cde	108.5bcd	1200efg
	30	79.0b-g	1005d-g	122abc	1250ef
s.e.d					
Genotype (G)		14.69	238.6	11.89	203.8
Phosphorous (P)		5.73	125.6	4.75	47.75
G × P		16.64		20.31	

The use of P fertilizer application is generally suggested to correct the P deficiency (Fageria et al., 1995), while the results of this study also showed significant grain yield responses to P (Table 7). However, this is not always possible for most resources-poor farmers due to high cost and non-availability of P fertilizer. Moreover, P fertilizer is generally quickly fixed into forms unavailable to plants by Fe and Al oxide found in the soil (Sample et al., 1980). Under such circumstances, it has been suggested that the integration of plant species or genotype that can make most efficient use of the P supplied by the soil represent a key element of sustainable cropping system (Horst et al., 2001). Wide differences in P acquisition and use have been documented among and within many legumes including soybean (Alves et al., 2003; Sanginga et al., 2000). It is therefore pertinent to place more emphasis on P use efficiency other than increased application of P fertilizer.

The rsults of this study show appreciable variations in P use of the evaluated genotypes under low available P conditions (Table 7). In 2003, TGX 1485-1D and TGX 1740-2F produced significantly higher grain yields at 0 kg P ha^{-1}, while TGX 1844-18E and TGX 1869-31E showed similar effect in 2004, suggesting good P acquisition and utilization of those genotypes at low P. Plants that are more efficient at acquiring soil P have been suggested to do so through better root development (Gahoonia and Nielson, 2004; Krasilnikoff et al., 2003), infection of root hairs by arbuscular mychorrhiza fungi (AMF) (Smith and Read, 1997), lowering of the pH of soil around the root, thereby solubilising P (Gahoonia et al., 1992), or secretion of high amount of ecto-enzymes making P bounded to organic matter available (Li et al., 1997; Marschner, 1995). It is therefore imperative that breeding and selection for P-efficient soybean genotypes should be given more emphasis in the crop improvement programme through selection for the above P-efficient characteristics. It can be concluded therefore, that even though soybean responds favourably to P fertilizer, the development of P-efficient technology will benefit resource-poor farmers more in this region, than the development of the optimum P level(s) which those farm-ers may not adopt and/or may not have resources to apply.

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